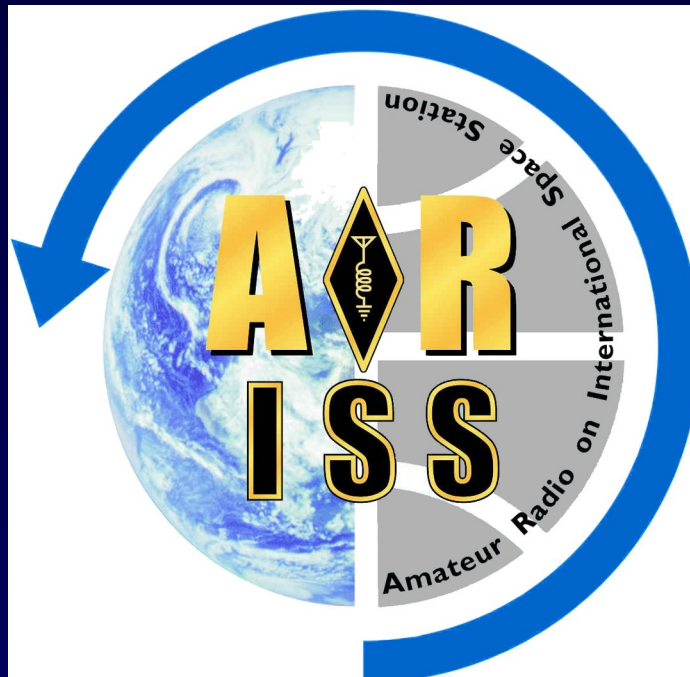


Human Spaceflight, ARISS & Future SuitSat Missions



Amsat Symposium
Oct 27, 2007

Frank H. Bauer, ka3hdo@amsat.org

Building & Operating Spacecraft Means Paying Attention to the Details



Amateur Radio on the International Space Station



What is ARISS?

- International program that inspires students, worldwide, to pursue careers in science, engineering and mathematics through communication with the ISS on-orbit crew via amateur radio
- Local community drawn into this once-in-a-lifetime human spaceflight pursuit
- Provides an experiment platform for new telecommunications techniques
- Promotes interest in the amateur radio (ham radio) hobby as a link to better engage students in science and math

ARISS development, operations and student mentoring is performed almost exclusively by a world-wide network of amateur radio volunteers who are passionately committed to the above objectives

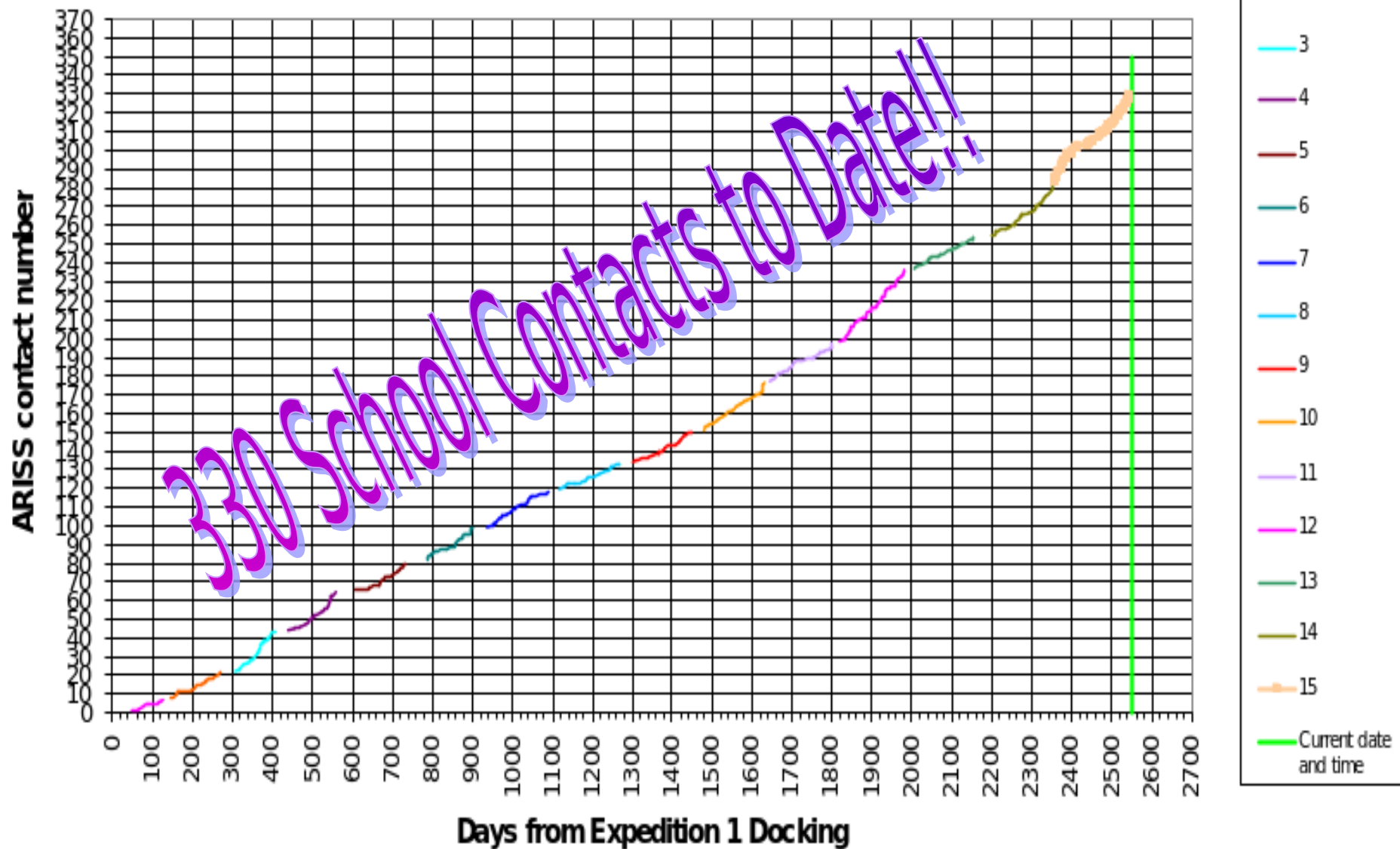


ARISS Capabilities & Impact

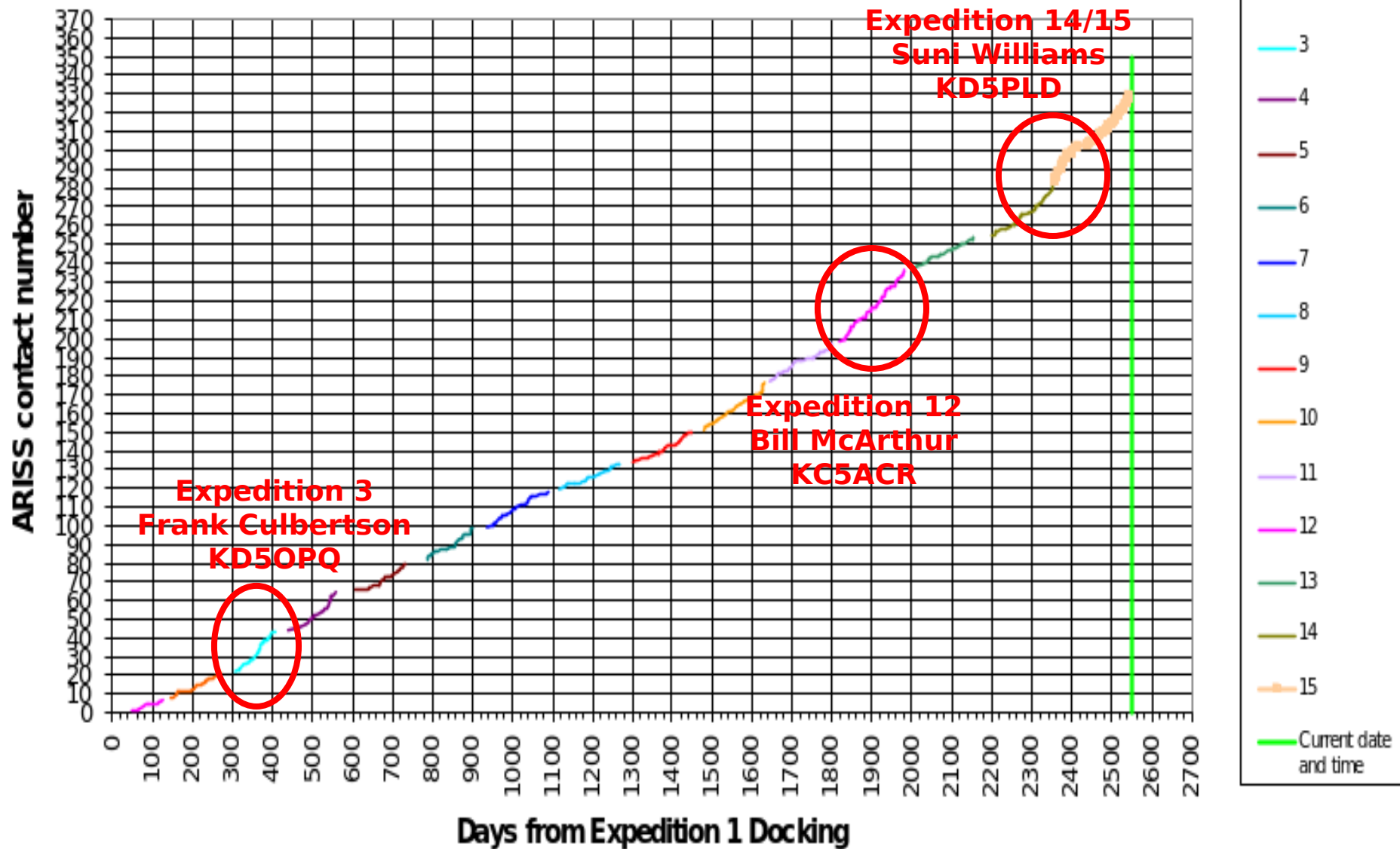
- FGB-mounted 2 m Ericsson radio for voice & packet
 - Operational less than 2 weeks after first crew arrival making **ARISS the first payload on ISS**
- Developed 4 multi-band antenna systems; mounted on the periphery of the Russian service module via 3 EVAs→**2 m, 70 cm, L band, S Band, HF and GPS**
- Developed and installed **2 L/S-band antennas** on European Columbus Module
- Installed UHF/VHF Kenwood D-700E in Service Module, near the dinner table and window
- Successful completion of over **330** international schools—kudos to the operations team and volunteer mentors on a job well done!
- **16 consecutive ISS expedition crews** used our radio system to conduct thousands of QSOs with hams on the ground since **November 2000**
- Over **15,000** students touched **each year**
- **Millions, worldwide** have heard an ARISS connection
- **Millions, worldwide** see ARISS contact on ISS IMAX film
- Witnessing students, worldwide, become scientists and engineers as a direct result of the ARISS connection
- The first Spacesuit satellite—SuitSat-1/Radioskaf deployed from ISS; **SuitSat-2 on the horizon.**



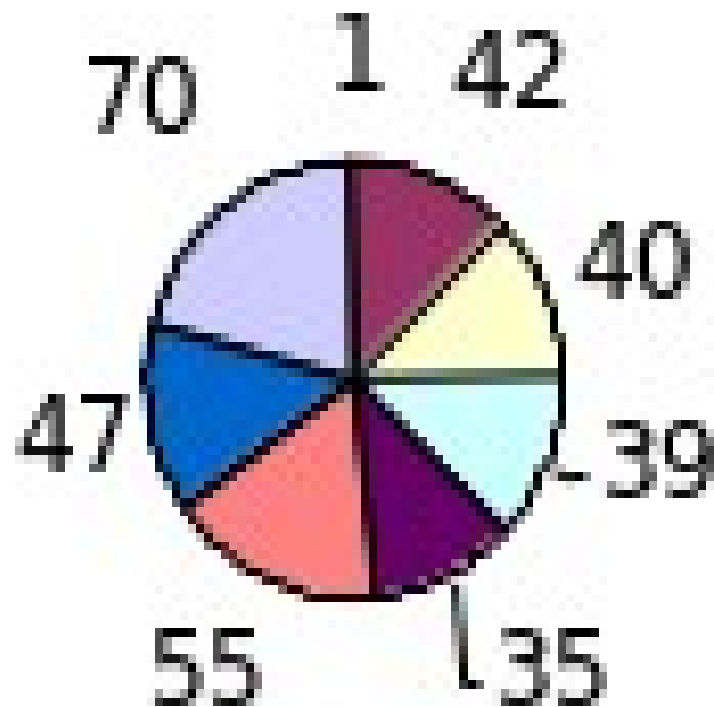
ARISS Total history running count from Expedition 1 Docking



ARISS Total history running count from Expedition 1 Docking



School Contacts Per Year



Crew School Contact Statistics

Top 5 expedition school contacts:

- 1) Exp 15—39
- 2) Exp 12—38
- 3) Exp 14—25
- 4) Exp 10—23
- 5) Exp 3—22

Top 5 individual school contact counts for a single tour:

- 1) Bill McArthur - 37—Exp 12
- 2) Suni Williams - 33—Exp 14/15
- 3) Leroy Chiao - 23—Exp 10
- 4) Frank Culbertson - 22—Exp 3
- 5) Clay Anderson - 21—Exp 15/16

Suni Williams
KD5PLD



2006-2007 Space Flight Participant

Anousheh
Ansari



Sheikh
Muszaphar
Shukor



Charles Simonyi



**Sputnik 50th
Anniversary**

**ARISS Contact
Air & Space
Museum
Sept 29, 2007**

Crew Ops Observations & Expectations

- Past few crews have been very prolific in performing school contacts (Bill McArthur, KC5ACR, Suni Williams, KD5PLD, Clay Anderson, KD5PLA)
- General QSOs sporadic; dependent upon crew interest
- High crew workload over next 6 months will result in little and at times no school or general QSO contacts on Expedition 16
 - Install and c/o US Harmony Node→ starting now
 - Install and c/o European Columbus Module→Next Shuttle flight
 - Install and c/o Japanese Kibo Module→follow-on Shuttle flight
 - 3 Shuttle flights
 - 2 Soyuz flights
 - Inaugural ATV (Europe Automated Transfer Vehicle) flight
- Packet ops will continue on 145.825 simplex
- Mid-2009 change to crew of 6 will significantly change ops dynamics
 - Many more schools and general QSOs??

	LAUNCH	CDR	FE-1	FE-2
		Yurchikhin RN3FI		
Exp. 15 Shuttle up	June 2007 (13A.1)*			Clay Anderson KD5PLA
Exp. 16 Soyuz up	October 2007*	Peggy Whitson KC5ZTD	Yuri Malenchenko PK3DUP	

Current Crew Complement
(Not including Shuttle Crew)

* Indicates planning date as of May 2007. Subject to change

	LAUNCH DATE	CDR	FE-1	FE-2
Exp. 14/15 Shuttle up	December 2007			Suni Williams KD5PLD
Exp. 15 Soyuz up	April 2007	Fyodor Yurchikhin RN3FI	Oleg Kotov	
Exp. 15 Shuttle up	June 2007 (13A.1)*			Clay Anderson KD5PLA
Exp. 16 Soyuz up	October 2007*	Peggy Whitson KC5ZTD	Yuri Malenchenko RK3DUP	
Exp. 16 Shuttle crew	Oct 2007 (10A)*	School Contacts Resume		Dan Tani KD5DXE
Exp. 16 Shuttle crew	Dec 2007 (1E)*			Leopold Eyharts KE5FNO
Exp. 16 Shuttle crew	Feb 2008 (1J/A)*			Garrett Reisman KE5HAE
Exp. 17 Soyuz up	March 2008*	Sergei Volkov	Oleg Kononenko RN3DX	
Exp. 17 Shuttle crew	July 2008 (15A)*			Sandy Magnus KE5FYE
Exp. 17 Shuttle crew	Oct 2008 (ULF2)*			Koichi Wakata KC5ZTA
* Indicates planning date as of May 2007. Subject to change				
Exp. 18 Soyuz up	October 2008	Michael Fincke	Alexander	

ARISS Update—Team, Hardware Status, Future Opportunities

2007 Delegate Changes

Stepping Down

**Ken Pulfer, VE3PU
Canada**



**Robin Haighton, VE3FRH
Canada**

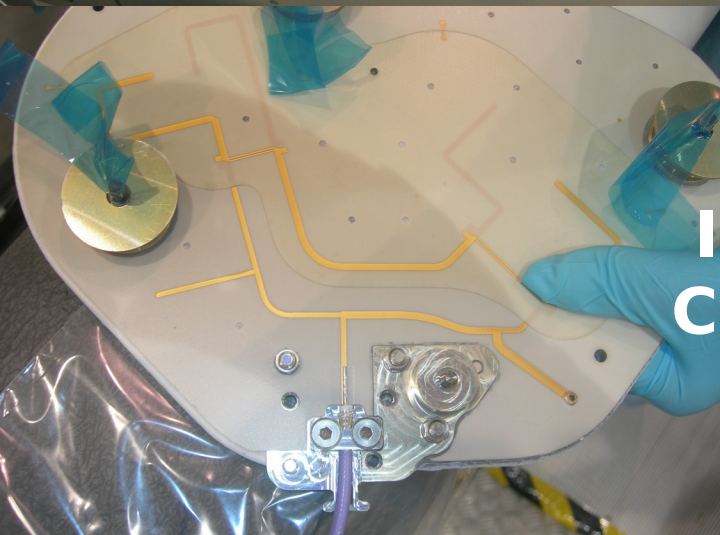
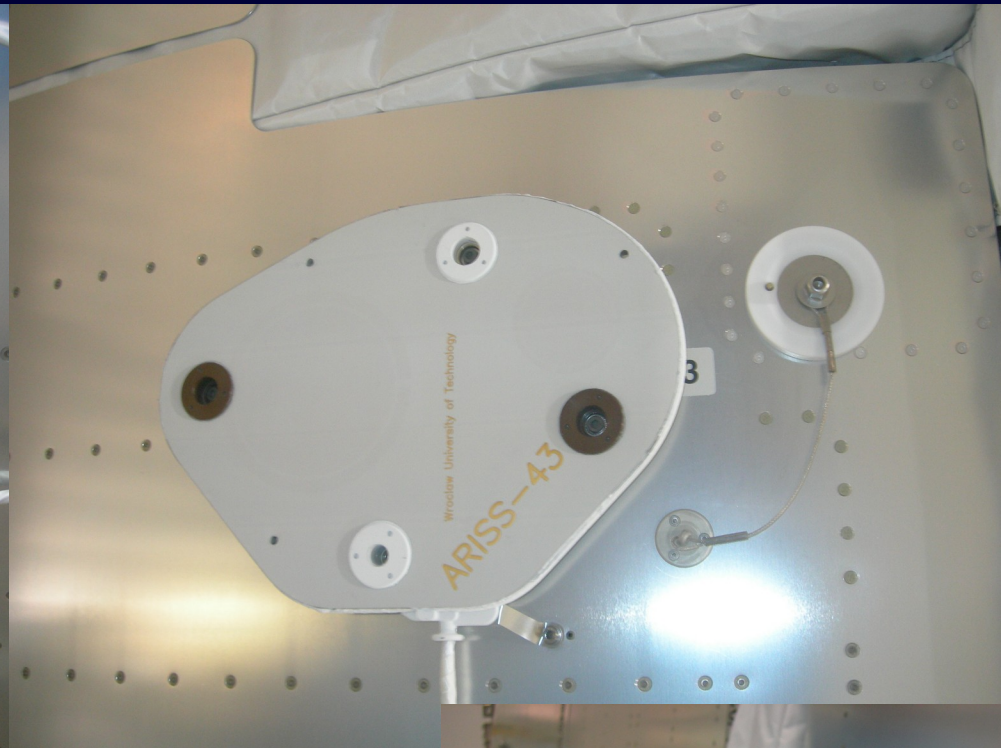
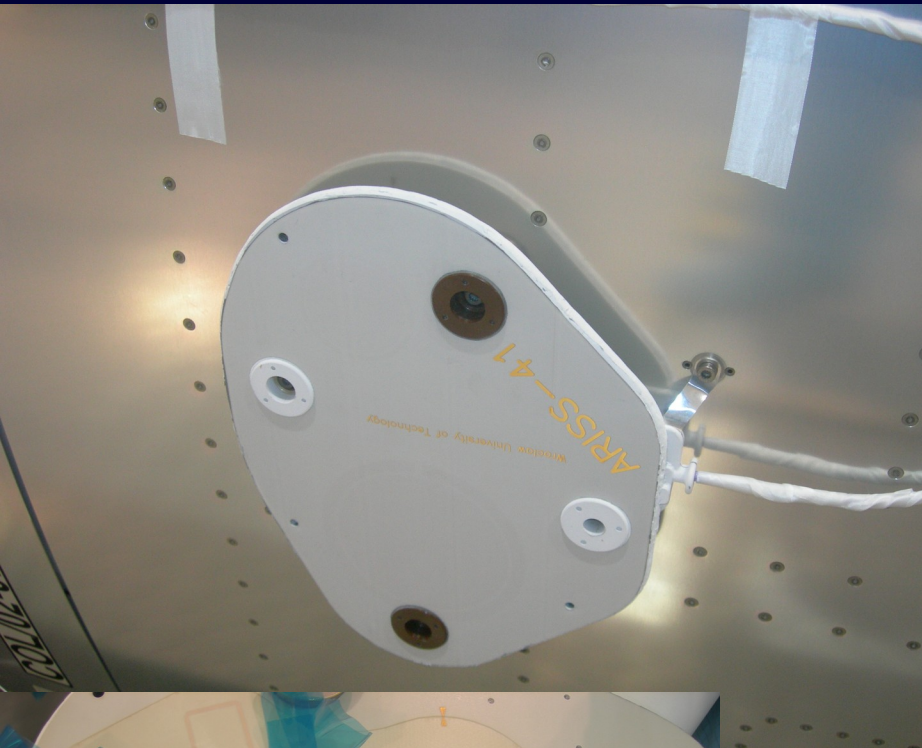
Stepping Up

**Daniel Lamoureux, VE2KA
Canada**

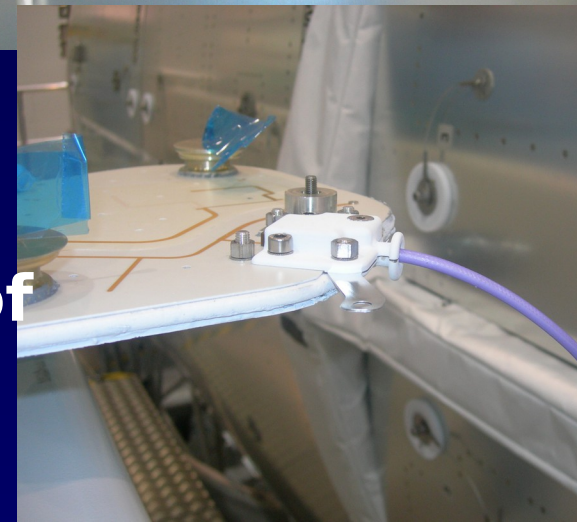


**Stefan Wagener, VE4NSA
Canada**

Two L/S Band Antennas Installed on European Columbus Module!!



**Installation & C/O
Completed Week of
October 20, 2007**



Hardware Development/Ops

Lessons Learned

- ISS is not like Mir→don't expect the same type of ops

Differences:

- Mir crew relied on ham radio equipment to support family contacts, radiograms, air to ground comm
- Ham radio on Mir was the prime external outlet for the crew
- ISS communications system much more robust
- IP Phone on ISS requires very few ARISS family contacts

Similarities:

- Proven educational outreach capability that requires nearly zero setup overhead
 - "Dyed in the wool" hams use the equipment extensively
- After 7 years of continuous operations little crew time for hardware installation, checkout or troubleshooting

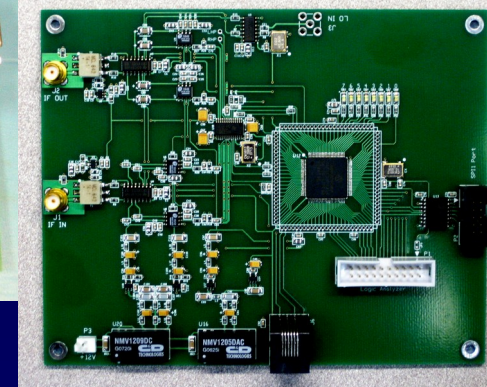
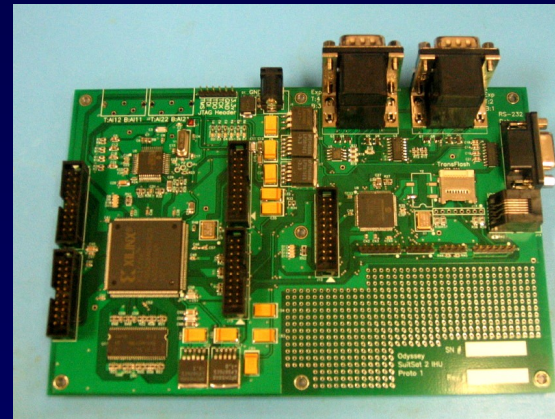
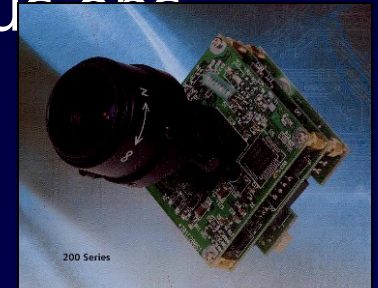
Lesson Learned

Future ARISS hardware needs to be Satellite-like (i.e. completely autonomous and commandable)

ARISS Phase 3 Hardware Concept



- Use SuitSat-2 core hardware to support multi-band autonomous operations
 - Voice
 - Packet
 - SSTV
 - Student Experiments



1996 ARISS Phase 3 Concept

SuitSat-2 Core Hardware

Current/Future Telebridge Stations

New VE4NSA Bridge Station

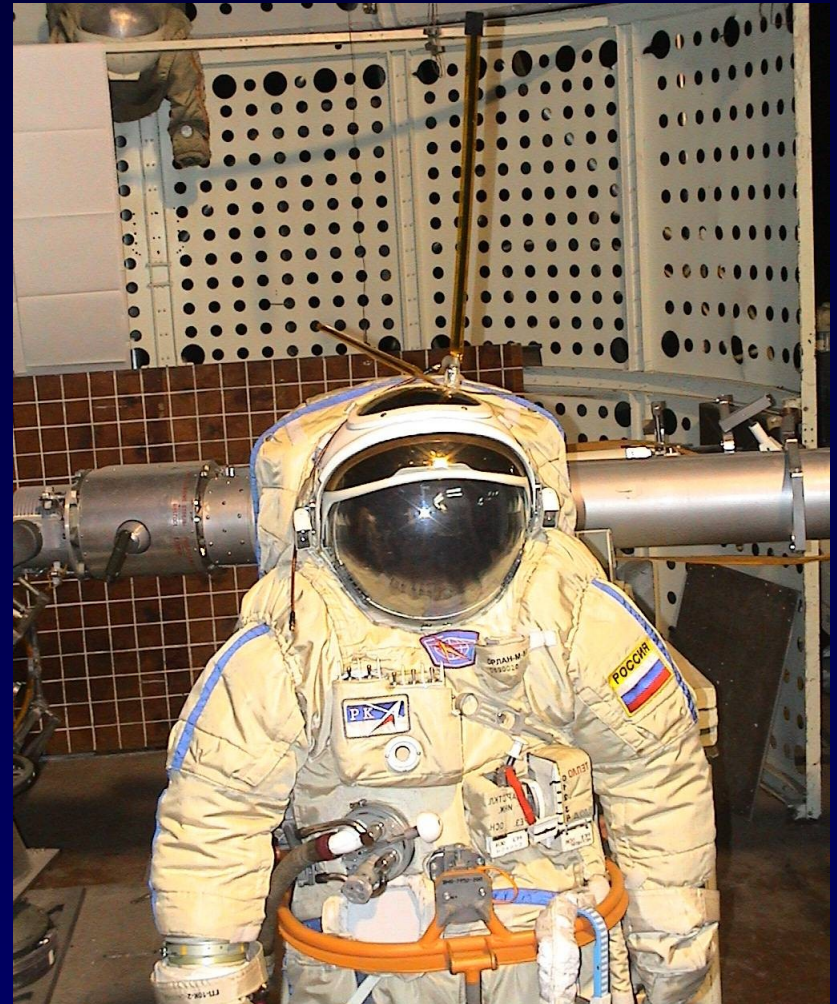


Proposed Augmentation of Bridge Stations (South America and High Latitude)



SuitSat-1--Amateur Radio Extra Vehicular Activity (EVA) In a Space Suit

- **2-week battery-operated satellite station**
- **Capabilities:**
 - International Student Message Downlink
 - SSTV Picture
 - Telemetry
 - School Spacewalk—DVD with school name, artwork and student names included
- **Deployment: Feb 3, 2006**
- **Re-entry: Sept 7, 2006**



The Amateur Radio on the International Space Station (ARISS) Team

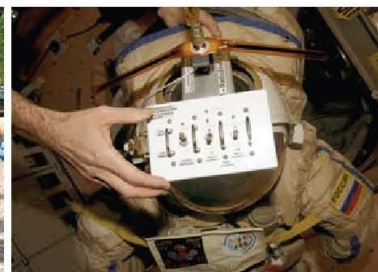
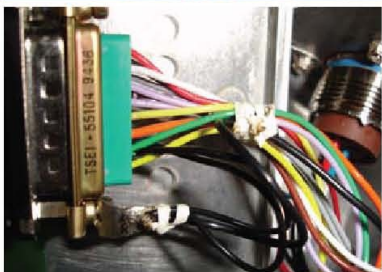
SuitSat-1/Radioskaf-1/AO-54

Certificate of Recognition

presented to

William C. McArthur
KC5ACR

Presented in recognition of your outstanding volunteer support to ensure the successful development, crew training, deployment, operations, educational outreach and information dissemination of the SuitSat-1 mission. As a result of your efforts, Suitsat-1 captured the imagination of people and students worldwide providing unprecedented outreach and visibility for a ham radio event.



The Amateur Radio on the International
Space Station (ARISS) Team

SuitSat-1/Radioskaf-1/AO-54

RSORS, Commemorative Certificate

presented to

Frank H. Bauer
KA3HDO

For Successful Reception of the SuitSat-1
radio downlink during its operation from
February 3, 2006–February 18, 2006.



The Amateur Radio on the International Space Station (ARISS) Team

is proud to present the

Chicken Little Prognostication Award

to

Aaron Russo
Student K-8

As one of the "Select Few" to successfully predict the reentry of the SuitSat-1/Radioskaf-1/AO-54 satellite.

SuitSat Deployment: February 3, 2006 @ 23:03 UTC
SuitSat-1 Reentry: September 7, 2006 @ 16:00 UTC



SuitSat-1 Chicken Little Contest Winners

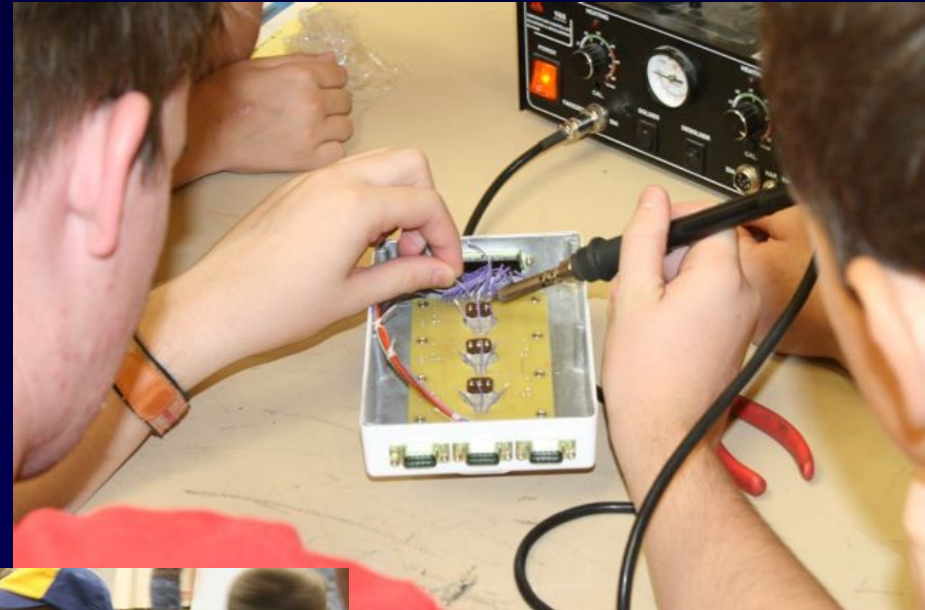
**Re-entry: September 7, 2006 at 16:00
GMT**

K-8 Student	High School Student	Adult
Aaron Russo - 10 August	Kaleb - 17 August	Brian W4OGU - 07 September
Kai Thomas - 12 August	Jconnop - 17 August	N3RCU - 07 September
Matt - 17 August	Joanna K W. - 17 August	SW6JIV - 07 September
Ralf Klebermass - 17 August	leila - 24 August	Beth Ransom - 07 September
Alexander Akers - 06 September	alex - 31 August	Kazumasa Ibata - 07 September
Joshuah - 11 September	Stanislav Babenko - 05 Sept	Reidar Larsen - 08 September
andy bond - 11 September	weathernut27 - 07 September	Chad Briggs - 08 September
Abriana - 15 September	mike - 08 September	kb3nds - 08 September
lucy bullfrog - 24 September	Addison Call - 10 September	nalro - 08 September
cameron... - 04 October	Richard - 03 October	kg6hsq - 09 September

SuitSat Future

- Design work underway for SuitSat-2
- Expected shipment to Russia: June 2008
- Expanded educational outreach
 - DVD with student pictures
 - Student audio downlinks
 - Pre-developed lesson plans (3 levels)
 - College students supporting hardware/software development
- Hardware Design features:
 - Proven SuitSat-1 safety interlock
 - Software Defined Transponder (SDX) system (RF & DSP)
 - New transmitter, receiver & antenna system
 - Solar arrays from NASA SMEX-Lite project
 - Additional sensors
 - SSTV with up to 4 cameras for SSTV downlink
 - Up to 4 experiment ports

Maricopa, Arizona Scouts Participate in SuitSat-2 Development September 13, 2007



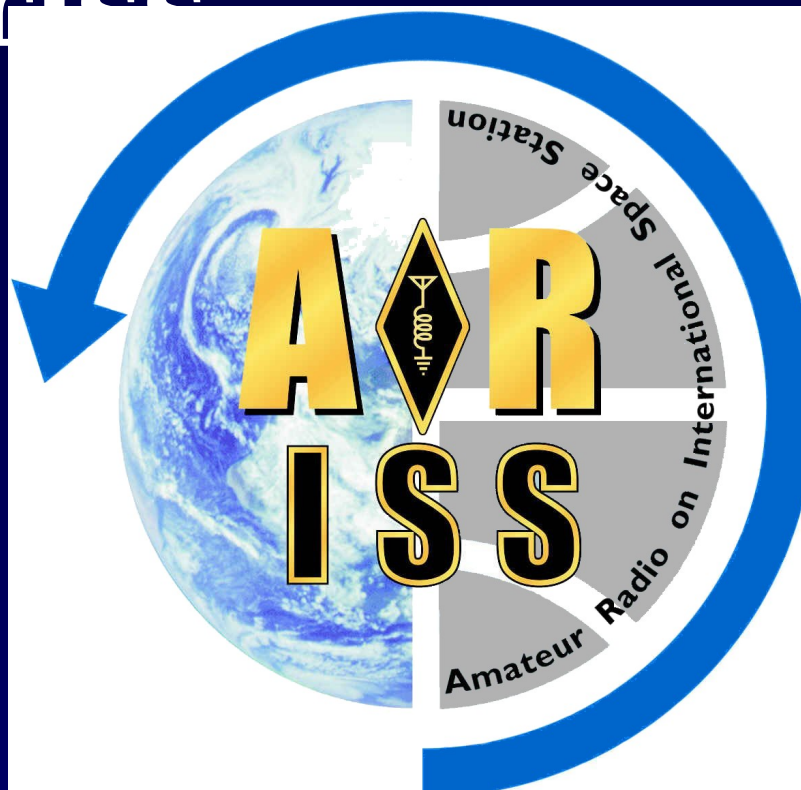
The Future

- On January 14, 2004, US President Bush proclaimed a new exploration initiative for NASA---go to the Moon by 2020, Mars next and beyond Mars later
- ARISS team developing Exploration Initiative strategy
- ARISS's solid performance and outstanding international teamwork is recognized and respected by the Space Agencies
- The challenges will be high due to the long path lengths



ARISS Information

[http://www.rac.ca/
ariss](http://www.rac.ca/ariss)

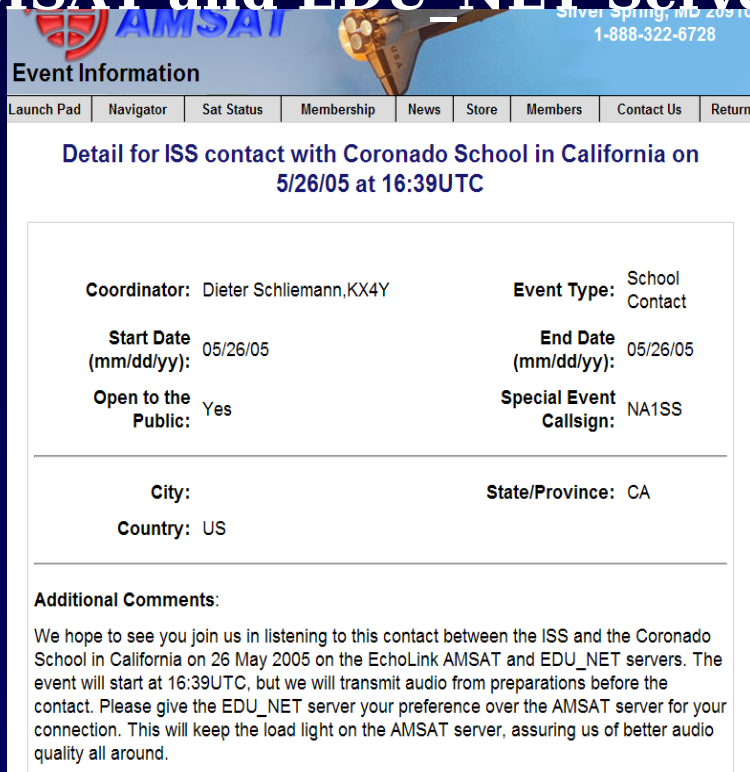


Backups

Voice Over Internet Protocol (VOIP)

IRLP, Echolink and Internet Streaming Provides a Wider Reach to Schools and Ham Radio Operators

Echolink AMSAT and EDU_NET Servers



AMSAT Silver Spring, MD 20910
1-888-322-6728

Event Information

Launch Pad | Navigator | Sat Status | Membership | News | Store | Members | Contact Us | Return

Detail for ISS contact with Coronado School in California on 5/26/05 at 16:39UTC

Coordinator: Dieter Schliemann, KX4Y	Event Type: School Contact
Start Date (mm/dd/yy): 05/26/05	End Date (mm/dd/yy): 05/26/05
Open to the Public: Yes	Special Event Callsign: NA1SS
City:	State/Province: CA
Country: US	

Additional Comments:

We hope to see you join us in listening to this contact between the ISS and the Coronado School in California on 26 May 2005 on the EchoLink AMSAT and EDU_NET servers. The event will start at 16:39UTC, but we will transmit audio from preparations before the contact. Please give the EDU_NET server your preference over the AMSAT server for your connection. This will keep the load light on the AMSAT server, assuring us of better audio quality all around.

www.amsat.org
Calendar of

IRLP 9010 "Discovery"



IRLP REFLECTOR 9010 DISCOVERY

Thursday, May 26, 2005

Time of connection to Reflector:
1625 UTC (approximately)

Participating School: Coronado Village School

Village Elementary School

Location: Coronado, California, USA

Time of School Contact with ISS:
1639 UTC (approximately)

Home News Events Sites Listen Contacts

NASA CSA ASC AMSAT AVER ISS

www.discoveryreflector.com

Columbus Module Antenna Installation and Inspection



Installation



Inspection